CLAIMS

What is claimed is:

1. A polymeric excavation structural support membrane comprising a polymer that is an initiator induced reaction product of a monomer; a fire retardant; and optionally at least one of a crosslinking agent, a second monomer, a smoke retardant, a rheology modifier, a reaction rate modifier, a plasticizer, an emulsifier, a defoamer, a filler, a wet surface adhesion modifier, and a coloring agent; wherein the monomer is selected from the group consisting of aryloxy alkyl acrylates, aryloxy alkyl methacrylates, and mixtures thereof; wherein the second monomer does not homopolymerize in the presence of the reaction rate modifier or the initiator; wherein the membrane has a tensile strength and thickness sufficient to provide support to exposed surfaces in an excavation.

2. The polymeric structural support membrane of claim 1, wherein the membrane comprises a polymer that is an initiator induced reaction product of a monomer, a crosslinking agent; a fire retardant; and optionally at least one of a second monomer, a smoke retardant, a rheology modifier, a reaction rate modifier, a plasticizer, an emulsifier, a defoamer, a filler, a wet surface adhesion modifier, and a coloring agent; wherein the monomer is selected from the group consisting of monofunctional aryloxy alkyl acrylates, monofunctional aryloxy alkyl methacrylates, and mixtures thereof.

3. The polymeric structural support membrane of claim 1 or 2, wherein the polymer is present in an amount from about 30% to about 70% by weight of the membrane, the self extinguishing additive is present from about 5% to about 40% by weight of the membrane, the initiator is present from about 1 to about 10% by weight of the monomer.

4. The polymeric structural support membrane of claim 2, wherein the monofunctional aryloxy alkyl methacrylates are selected from the group

consisting of 2-phenoxyethyl methacrylate 2-phenoxy-propyl-methacrylate, and mixtures thereof.

5. The polymeric structural support membrane of claim 1 or 2, wherein the fire retardant is selected from the group consisting of phosphates, exfoliated graphite, and mixtures thereof.

6. The polymeric structural support membrane of claim 5, wherein the phosphate is selected from the group consisting of polyammonium phosphate, monoammonium phosphate, triphenyl phosphate, and tri(2-chloroethyl) phosphate.

7. The polymeric structural support membrane of claim 1 or 2, wherein the initiator is an oxidizing agent.

8. The polymeric structural support membrane of claim 7, wherein the oxidizing agent is selected from the group consisting of peroxides, hydroperoxides, persulfates, and mixtures thereof.

9. The polymeric structural support membrane of claim 8, wherein the peroxide is selected from the group consisting of benzoyl peroxide and dibenzoyl peroxide.

10. The polymeric structural support membrane of claim 8, wherein the persulfate is ammonium persulfate.

11. The polymeric structural support membrane of claim 8, wherein the hydroperoxide is cumyl hydroperoxide.

12. The polymeric structural support membrane of claim 1 or 2, wherein the crosslinking agent is selected from methylene bis acrylamide, polymethylmethacrylate, butadiene styrene acrylate, styrene butyl acrylate copolymer, 1,6-hexanediol dimethacrylate, ethoxylated bisphenol A dimethacrylate, polyethylene glycol dimethacrylate, and mixtures thereof.

13. The polymeric structural support membrane of claim 1 or 2, wherein the second monomer is selected from the group consisting of diethylene glycol monoethyl ether dimethacrylate, diethylene glycol monobutyl ether dimethacrylate, and mixtures thereof.

14. The polymeric structural support membrane of claim 1 or 2, wherein the smoke retardant is aluminum oxide.

15. The polymeric structural support membrane of claim 1 or 2, further characterized by at least one of the following:

a. the crosslinking agent is present up to about 30% by weight of the monomer;

b. the rheology modifier is present up to about 10% by weight of the monomer;

c. the emulsifier is present up to about 5% by weight of the monomer;

d. the plasticizer is present up to about 40% by weight of the monomer;

e. the filler is present up to about 40% by weight of the monomer;

f. the wet surface adhesion modifier is present up to about 3% by weight of the monomer;

g. the coloring agent is present up to about 3% by weight of the monomer;

h. the defoamer is present up to about 3% by weight of the monomer;

i. the reaction rate modifier is present up to about 10% by weight of the monomer; and

j. the smoke retardant is present up to about 10% by weight.

16. The polymeric structural support membrane of claim 1 or 2, wherein the emulsifier is selected from the group consisting of anionic surfactants, nonionic surfactants, and mixtures thereof.

17. The polymeric structural support membrane of claim 16, wherein the emulsifier is selected from the group consisting of ethoxylated nonyl phenol, lauryl sulfates, and mixtures thereof.

18. The polymeric structural support membrane of claim 1 or 2, wherein the rheology modifier is selected from the group consisting of fumed silica, hydroxyethyl cellulose, hydropropyl cellulose, fly ash, mineral oil, tetra alkyl ammonium hectorite clay, and mixtures thereof.

19. The polymeric structural support membrane of claim 1 or 2, wherein the reaction rate modifiers are reducing agents.

20. The polymeric structural support membrane of claim 19, wherein the reducing agents are selected from the group consisting of anilines, amines, glycols, octoates, and mixtures thereof.

21. The polymeric structural support membrane of claim 1 or 2, wherein the filler is selected from the group consisting of crushed glass, metal such as iron particles, quartz, silica, barytes, limestone, sulfates, alumina, various clays, diatomaceous earth, wollastonite, mica, perlite, flint powder, kryolite, alumina trihydrate, talc, sand, pyrophylite, granulated polyethylene, fibers such as polypropylene or steel, aluminum oxide, zinc oxide, titanium dioxide, and mixtures thereof.

22. The polymeric structural support membrane of claim 1 or 2, wherein the wet surface adhesion modifier is selected from the group consisting of metallic acrylate, metallic methacrylate, ammonium oleate, magnesium oleate, ammonium acrylate, metal borates, and mixtures thereof.

23. The polymeric structural support membrane of claim 1 or 2, wherein the plasticizer is selected from the group consisting of lauryl methacrylates, stearyl methacrylates, ethoxylated(4) nonyl phenol (meth)acrylate, and mixtures thereof.

24. The polymeric structural support membrane of claim 1 or 2, wherein the membrane is at least about 1.5mm thick.

25. The polymeric structural support membrane of claim 24, wherein the membrane is about 2mm to about 6mm thick.

26. The polymeric structural support membrane of claim 1 or 2, wherein the membrane is characterized by at least one of:

a. an elongation greater than about 25% after about 24 hours from being formed;

b. an elongation greater than about 50% after about 8 hours from being formed;

c. an elongation greater than about 75% after about 2 hours from being formed;

d. a tensile strength greater than about 1 MPa after about 24 hours from being formed;

e. a tensile strength greater than about 1 MPa after about 6 hours from being formed;

f. a tensile strength greater than about 1 MPa within about 30 minutes from being formed;

g. an adhesion strength greater than about 0.5MPa after about 24 hours from being formed;

h. an adhesion strength greater than about 1 MPa after about 8 hours from being formed;

i. an adhesion strength greater than about 0.5 MPa within about 30 minutes from being formed; and

j. a water resistance as measured by having less than about 5% loss of tensile strength when immersed in room temperature water for about 24 hours.

27. The polymeric structural support membrane of claim 1 or 2, wherein the membrane is a reaction product of a first component and a second component; wherein the first component comprises a monomer, a crosslinking agent, a reaction rate modifier, a self-extinguishing agent, a rheology modifier, a filler, and a defoamer; and the second component comprises an initiator, a self-extinguishing agent, a rheology modifier, a wet surface adhesion modifier, and a defoamer.

28. The polymeric structural support membrane of claim 27, wherein the first component comprises 2-phenoxyethyl methacrylate, ethoxylated bisphenol A dimethacrylate, N,N-Dimethyl-P-Toluidine, natural graphite flake, fumed silica, mineral oil, titanium dioxide, zinc borate, smoke retardant, and defoamer; and wherein the second component comprises tri(2-chloroethyl) phosphate, mineral oil, benzoyl peroxide, fumed silica, zinc borate, and defoamer.

29. The polymeric structural support membrane of claim 27, wherein the first component comprises 2-phenoxyethyl methacrylate, at least one of ethoxylated bisphenol A dimethacrylate and trimethylolpropane trimethacrylate, N,N-Dimethyl-P-Toluidine, ethoxylated(4) nonyl phenol (meth)acrylate, polyammonium phosphate, aluminum oxide, fumed silica, mineral oil, titanium dioxide, zinc borate, and defoamer; and wherein the second component comprises polyammonium phosphate, aluminum oxide, mineral oil, benzoyl peroxide, fumed silica, zinc borate, and defoamer.

30. The polymeric structural support membrane of claim 1 or 2, wherein the membrane is a reaction product of a first component, a second component, and a third component; wherein the first component comprises a first monomer, a crosslinking agent, a self-extinguishing agent, a smoke retardant, a rheology modifier, and a defoamer; and the second component comprises a second monomer, an initiator, a rheology modifier, a smoke retardant, and a defoamer; and the third component comprises the second monomer, a reaction rate modifier, and a defoamer, wherein the second monomer comprises at least one monomer other than the first monomer.

31. The polymeric structural support membrane of claim 30, wherein the first component comprises 2-phenoxyethyl methacrylate, trimethylolpropane trimethacrylate, polyammonium phosphate, aluminum oxide, fumed silica, and defoamer; and the second component comprises diethylene glycol monoethylether methacrylate, benzoyl peroxide, fumed silica, aluminum

oxide, and defoamer; and the third component comprises diethylene glycol monoethylether methacrylate, N,N, Dimethyl P Toluidine, and defoamer.

32. The polymeric structural support membrane of claim 1 or 2, wherein the membrane is a reaction product of a first component, a second component, a third component, and a fourth component; the first component comprises a first monomer, a cross-linking agent, a fire retardant, a rheology modifier, a smoke retardant, a coloring agent, a filler, and a defoamer; the second component comprises a reaction rate modifier, a second monomer, a rheology modifier, a coloring agent, and a filler; the third component comprises the first monomer, a rheology modifier, a coloring agent, and a filler; and the fourth component comprises an initiator, the second monomer, a rheology modifier, a fire retardant, a smoke retardant, a coloring agent, and a filler, wherein the second monomer comprises at least one monomer other than the first monomer, and wherein the first monomer comprises at least one monomer other than the second monomer.

33. The polymeric structural support membrane of claim 32, wherein the first component comprises 2-phenoxyethyl methacrylate, trimethylolpropane trimethacrylate, polyammonium phosphate, fumed silica, aluminum oxide, titanium dioxide and defoamer; the second component comprises N,N, Dimethyl P Toluidine, diethylene glycol monoethylether methacrylate, fumed silica, titanium dioxide; and the third component comprises 2-phenoxyethyl methacrylate, fumed silica, titanium dioxide; and the fourth component comprises benzoyl peroxide, diethylene glycol monoethylether methacrylate, fumed silica, polyammonium phosphate, aluminum oxide, and titanium dioxide.

34. A method of reinforcing exposed surfaces in an excavation with a polymeric structural support membrane comprising:

a. applying to the exposed surface a mixture comprising a monomer; an initiator, a fire retardant; and optionally at least one of a crosslinking agent, a second monomer, a smoke retardant, a rheology modifier, a

reaction rate modifier, a plasticizer, an emulsifier, a defoamer, a filler, a wet surface adhesion modifier, and a coloring agent; wherein the monomer is selected from the group consisting of aryloxy alkyl acrylates, aryloxy alkyl methacrylates, and mixtures thereof, wherein the second monomer does not homopolymerize in the presence of the reaction rate modifier or the initiator; and

b. reacting the mixture;

wherein the membrane has a tensile strength and thickness sufficient to provide support to the exposed surfaces in the excavation.

35. The method of claim 34, wherein said applying is selected from the group consisting of spraying, brushing, rolling, and combinations thereof.

36. The method of claim 34, wherein the tensile strength is at least 1 MPa and the thickness is about 1.5mm to about 6mm.

37. The method of claim 34 further defined by four components, wherein:

a. the first component comprises a first monomer, a cross-linking agent, a fire retardant, a rheology modifier, a smoke retardant, a coloring agent, a filler, and a defoamer; the second component comprises a reaction rate modifier, a second monomer, a rheology modifier, a coloring agent, and a filler; the third component comprises the first monomer, a rheology modifier, a coloring agent, and a filler; and the fourth component comprises an initiator, the second monomer, a rheology modifier, a fire retardant, a smoke retardant, a coloring agent, and a filler, wherein the second monomer comprises at least one monomer other than the first monomer, and wherein the first monomer comprises at least one monomer other than the second monomer;

b. components one and two are supplied to one chamber of a pumping means, and components three and four are supplied to a second chamber of said pumping means;

c. said pumping means delivers the materials to a spraying apparatus to spray the formulation onto a surface;

d. components one, two, three, and four are then sprayed onto a surface where they react to form the membrane;

wherein the membrane has a tensile strength and thickness sufficient to provide support to the exposed surfaces in the excavation.

38. The method of claim 37 wherein the pumping means combines components one and two as a first unit and components three and four as a second unit in a volume ratio of about 3 to 1.

39. The method of claim 38 further characterized in that components one and two provide 3/4 of the total volume of the material delivered that forms the membrane, and components three and four provide 1/4 of the total volume.

40. A polymeric structural support membrane formed from the process comprising:

a. applying to an exposed surface in an excavation a mixture comprising a monomer; an initiator, a fire retardant; and optionally at least one of a crosslinking agent, a second monomer, a smoke retardant, a rheology modifier, reaction rate modifier, a plasticizer, emulsifier, defoamer, filler, wet surface adhesion modifier, and coloring agent; wherein the monomer is selected from the group consisting of aryloxy alkyl acrylates, aryloxy alkyl methacrylates, and mixtures thereof, wherein the second monomer does not homopolymerize in the presence of the reaction rate modifier or the initiator; and

b. reacting the mixture;

wherein the membrane has a tensile strength and thickness sufficient to provide support to the exposed surfaces in the excavation.

41. The polymeric structural support membrane of claim 40, wherein the tensile strength is at least 1 MPa and the thickness is about 1.5mm to about 6mm.